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Effect of Soybean Milk on Rat Serum Lipid Levels

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The effect of soymilk on rat serum lipid levels was investigated using weanling male albino rats. The results showed that rats fed soymilk gained more weight than the control groups ($p<0.01$). Similarly, soymilk was found to decrease serum lipids (total cholesterol, triacylglycerol and phospholipid), while the HDL-cholesterol fractions increased ($p<0.01$). The implication of soymilk in disease states associated with lipid metabolism is discussed.

Keywords : Soymilk, Serum lipids, Lipid metabolism.

The major use of soybean is in the production of soybean oil and meal (Thomas et al. 1984). However, there is a smaller but still important market for direct conversion of soybean to products such as soymilk, *tofu*, *natto* and *tempeh*. Soymilk is a food product in its own right and also serves as the intermediate in the production of *tofu* (Norman 1978). The food is popular in the developed countries especially amongst the orients. However, in the developing countries like Nigeria, the increasing demand for food materials, rich in proteins necessitated research efforts to understand the complete nutritional value as well as metabolic effect of several common soybean cultivars (Nsofor and Chukwu 1992; Oke and Umoh 1978). There are many reports on the hypolipidemic effects of the oil extracted from this plant (Kajimoto et al. 1984). There are also many reports in literature on the hypolipidemic effects of dairy products (Halinow and McLaughlin 1975; Mann 1977). Since soybean and its products are encouraged in the diet of many low income earners and infants in Nigeria, it was thought of interest to investigate the effect of the soymilk on serum lipids of weaning albino rats for evaluating its nutritional quality. The results of the investigation are presented in this communication.

Fresh soybean seeds obtained from the Department of Home Science and Nutrition, Faculty of Agriculture, University of Nigeria, Nsukka, Nigeria were dried in the sun (moisture 5.0%) and milled prior to preparation of the milk.

Preparation of soymilk : One hundred and fifty grams of beans were washed in distilled water and soaked for 16 h at 20°C in 500 ml of distilled water. The soaked bean was drained for 4 min. To this slurry was added 400 ml of boiling water, additional water was added, if necessary to make up differences in water imbibed during soaking. The milk was filtered by means of a juicer and stored in the refrigerator till used.

Determination of proteins : The protein contents of whole soybean meal and soymilk were determined by the micro-Kjeldahl method and the multiplication factor of 6.25 was used to convert nitrogen to proteins.

Nutritional studies : These studies were carried out for 35 days, using weanling male albino rats of the Wistar strain. The rats, which were of similar weight, were divided into 2 groups (A and B). The animals were fed on a normal rat 'chow' (Top feeds: 72.5% carbohydrates, 26.5% proteins and 1.0% fat) except those on Group B (experimental rats) were placed on 100 ml of soymilk everyday for 5 weeks, while the Group A rats (control rats) were given 100 ml of distilled water. There were 10 rats in each group. Before feeding, the young rats were separated from their mothers, fasted overnight and were then fed on the appropriate diets for a period of 5 weeks. The rats were allowed access to feed, soymilk and water *ad libitum*.

Lipid analysis : At the end of every week, two rats from each group were sacrificed for analysis. Serum was removed after low speed centrifugation (1000 x g) for 10 min. Analysis was carried out immediately.

Total cholesterol was determined by the method of Searcy and Berquist (1960) HDL-cholesterol by the method of Burnstein et al (1970) phospholipids by the method of Stewart (1980) and triacylglycerol by the method of Gottfried and Rosenberg (1973). Statistical analysis was done by using student's 't' test.

The protein contents of the soybean meal and soymilk used in the present study were 37.5 and

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TABLE 1. SERUM LIPID LEVELS (mg/100 ml) IN RATS FED SOYMILK SUPPLEMENTED DIET

	Time, weeks				
	1st week	2nd week	3rd week	4th week	5th week
Triacylglycerol (Control)	141.2 ± 3.5	121.5 ± 3.7	126.2 ± 4.2	130.6 ± 3.2	130.8 ± 15.9
Triacylglycerol (Soymilk fed)	137.0 ± 0.8	126.2 ± 3.5	123.7 ± 10.6	106.3 ± 3.5	99.4 ± 15.9
Total cholesterol (Control)	60.5 ± 3.5	62.5 ± 3.5	67.5 ± 3.5	87.5 ± 3.5	130.6 ± 7.1
Total cholesterol (Soymilk fed)	75.5 ± 10.6	69.0 ± 1.4	52.5 ± 3.5	62.5 ± 1.8	33.7 ± 1.8
HDL cholesterol (Control)	46.9 ± 15.9	41.8 ± 3.5	44.8 ± 3.5	47.0 ± 7.1	59.7 ± 22.9
HDL cholesterol (Soymilk fed)	41.5 ± 7.1	46.9 ±15.9	45.2 ± 8.8	43.0 ± 14.1	39.5 ± 3.5
Phospholipids (Control)	51.5 ± 3.5	52.5 ± 0.7	54.5 ± 0.7	57.0 ± 1.4	83.5 ± 3.5
Phospholipids (Soymilk fed)	74.0 ± 1.4	110.5 ± 3.5	83.0 ± 2.8	80.5 ± 0.8	56.5 ± 0.1

$p > 0.01$ for serum lipids (total cholesterol, phospholipids and triacylglycerol), $p < 0.01$ for serum HDL-cholesterol

29.8%, respectively and were high as compared with earlier reports (Mba and Nnanyelugo 1989). The rats on soymilk consumed their daily rations satisfactorily and showed increases in body weights higher than the control rats, the weight gain being 40 g. Similarly, there were decreases in serum cholesterol, triacylglycerol, phospholipids and an increase in HDL-cholesterol fraction of rats fed soymilk ($p < 0.01$) when compared with the control groups (Table 1). The actual reason for the increases in body weights of the rats fed soymilk is not clear. However, it is believed that the increase in body weight may be the result of the extra nutrient supplied by the soymilk (proteins, carbohydrates and fat), which are essential nutrients for the supply of energy and repair of tissues (Mba and Nnanyelugo 1989) and support earlier reports on increase in the body weight observed in weanling albino rats fed skim milk and other dairy products, as compared to the control animals (Malino and McLaughlin 1975; Mann 1977). Of interest was the lowering of serum lipids observed in this study and elevation of HDL-cholesterol lipoproteins. There are also reports on lowering of serum lipids by soybean oil and not the milk (Mba and Nnanyelugo 1989). This possibly compliments the research efforts on dairy and dairy products as well as dairy product supplements. The lowering of serum cholesterol and triacylglycerol is of nutritional importance. Some speculations might explain the observed results, namely the low levels of sterol observed in soybean and soymilk products (Kajimoto et al. 1984; Mba and Nnanyelugo 1989), or possibly the level of Ca^{2+} content of the milk (Mba and Nnanyelugo 1989), as this has been found to play an important role in lowering the cholesterol level in the experimental rat (Terry et al. 1985). It is equally possible that the lowering of cholesterol in rats fed soymilk might be the result of high levels of proteins present in the milk, as there are reports of some proteins acting on a key enzyme that regulates cholesterol metabolism in rat liver HMG-COA reductase, (Malinow and McLaughlin 1975). However, this needs further confirmation. Horigome et al (1992) have reported that soyproteins are hypocholesterolemic, compared to casein. The results obtained on the triacyl-glycerol levels are equally interesting, as the present study has shown that the levels of serum triacylglycerol was low in rats fed soybean. This again might be nutritionally beneficial in formulating diets for obese people, as possibly the milk may be low in triacylglycerol (storage fat) or the storage fat of soymilk is easily utilized and metabolised accounting for its low levels in the serum. Phospholipids, on the other hand, possibly might have been utilized as a substrate for the enzyme lecithin cholesterol acyl transferase (LCAT) in the esterification of cholesterol and may further support the low cholesterol levels observed in this study. Similarly, the phopholipids may have been used up in biosynthetic pathways or possibly the levels of polyunsaturated fatty acids in the soymilk might have influenced the serum levels (Meena et al. 1983). In general, this study has indicated lipid lowering effect of this important protein supplement. This compliments the numerous research reports on hypolipidemic effects of soy and soybean products.

Since the soymilk is a cheap source of proteins and found to be hypolipidemic, it could play a dual role of a protein supplement as well as an antilipidemic agent. However, further research needs to be carried out on the shelf life of the milk as well as identification of the proteins that may play important roles in lowering serum lipid levels.

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